MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

EEL1016 – ENERGY CONVERSION I

(LE)

10 MARCH 2017
9 AM – 11 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This examination paper consists of 4 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Explain the reason for the following statements in a power system:
(i) Delta-connected load is more common compared to the star-connected load. [2 marks]

(ii) Delta-connected sources are not common in practice. [2 marks]

(b) Name the THREE disadvantages of low power factor. [6 marks]

(c) Figure Q1 shows a balanced star-delta connected system. The per-phase impedance of the load is given as $Z_\Delta = 18 + j24\ \Omega$. Assume positive phase sequence and take V_{an} as the reference phasor.

(i) Perform delta-to-star transformation at load side. [1 mark]
(ii) Sketch the per phase phase-*a* equivalent circuit after the load transformation in Part (i). [2 marks]
(iii) Calculate the line current. [2 marks]
(iv) Prove that the neutral current is zero. [4 marks]
(v) Determine the power factor and total power taken by the load. [4 marks]
(vi) Draw the phasor diagram of phase-*a* current and voltage. [2 marks]

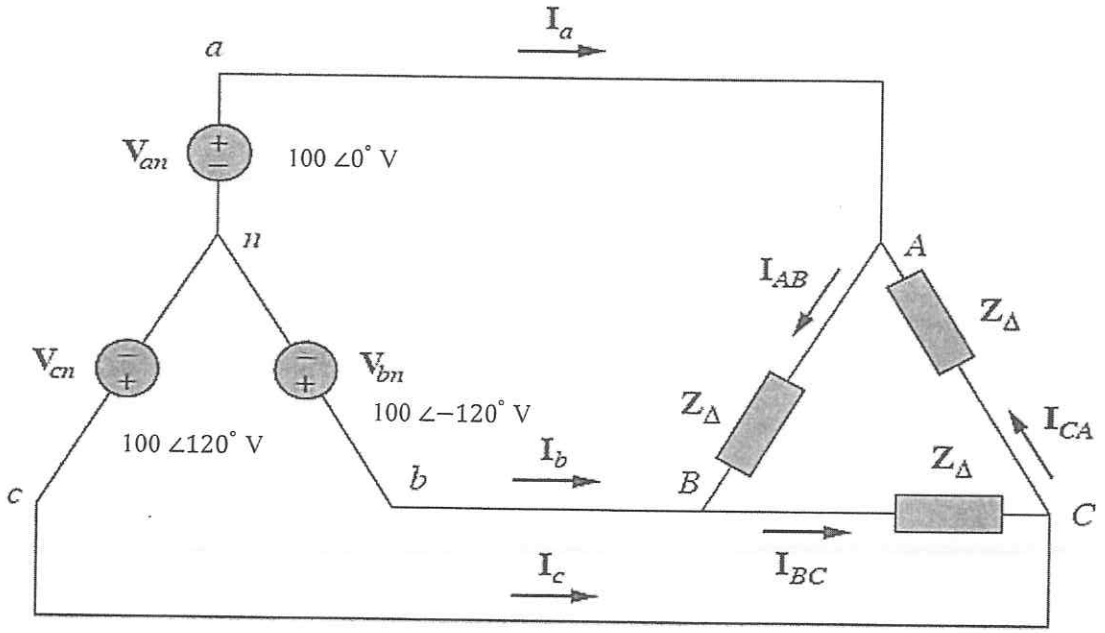

Figure Q1

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Question 2

(a) What is the importance of the polarity in a transformer? [3 marks]

(b) A 2000 VA, 230/115 V single-phase transformer has been tested to determine its equivalent circuit. The results of the test are:

$V_{OC} = 230\ V$	$V_{SC} = 13.8\ V$
$I_{OC} = 0.55\ A$	$I_{SC} = 8.696\ A$
$P_{OC} = 45\ W$	$P_{SC} = 21.5\ W$

(i) From the given test data, determine the location of the connected measurement meters. That is, whether the meters are connected at the low- or high-voltage side. [3 marks]

(ii) Find the simplified equivalent circuit of the transformer while referring to the low voltage side. [14 marks]

(iii) Determine the efficiency at rated condition and at 0.75 *pf* lagging. [5 marks]

Question 3

(a) Squirrel cage and wound rotor are two types of rotors used in induction motors. Compare them in terms of efficiency, construction, cost and starting torque. [4 marks]

(b) Figure Q3 shows the per-phase exact equivalent circuit of an induction motor. It is a 3-phase 380-V, 60-Hz, 6-pole motor with a full load output of 38 kW at the efficiency of 88%. The motor operates at 0.85 *pf* lagging with a slip of 0.03 and the motor full load stator copper losses are 1.1 kW.

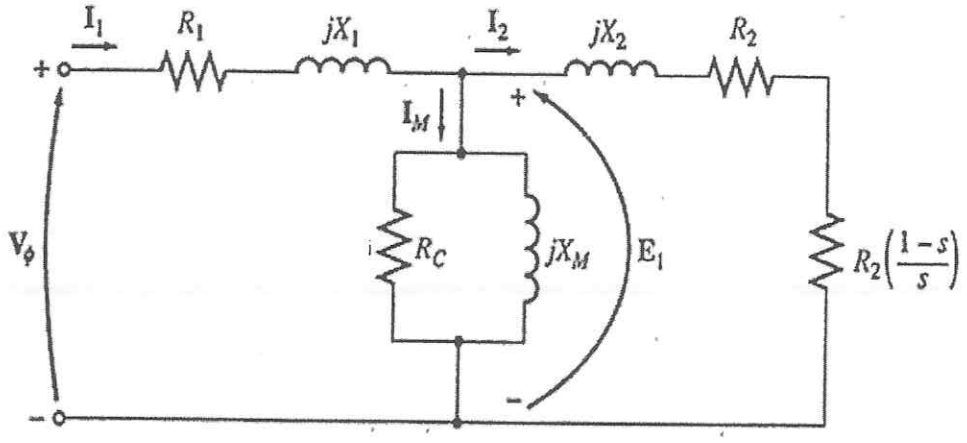

Figure Q3

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(i) Sketch the power-flow diagram for the motor circuit shown in Figure Q3. [5 marks]

(ii) Calculate the motor speed. [2 marks]

(iii) Find the line current. [4 marks]

(iv) Determine the rotor copper loss. [4 marks]

(v) Calculate the rotational loss. [3 marks]

(vi) With the same line current in Part (iii), what should be the new power factor to achieve 95% efficiency? [3 marks]

Question 4

(a) Rotor Windings and Stator Windings are two terms commonly used to describe the windings of synchronous machines. State the major difference between these windings. [2 marks]

(b) The internal generated voltage produced in the synchronous machines is not usually the voltage that appears at the terminals of the generator (output voltage). What could be the factors that cause the difference between these two voltages? Assume the rotor for the machines is non-salient pole type. [3 marks]

(c) A 200-V, 60-kVA, delta connected, 50-Hz synchronous motor has a synchronous reactance of 3 Ω/phase. and a negligible armature resistance. Its friction and windage losses are 1.2 kW, and its core losses are 1.0 kW. Initially, the shaft is supplying 13.423 kW load, and the motor's power factor is 0.7 leading.

(i) Calculate the per phase armature current (I_A), line current (I_L) and internal generated voltage (E_A). [10 marks]

(ii) Sketch the phasor diagram of this motor for the parameters obtained in Part (i). [2 marks]

(iii) Assuming that the field excitation is held constant when the shaft load is increased to 22.371 kW, find I_A, I_L, and E_A after the change in load. [8 marks]

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